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TRANSACTIONS

OF THE

AMERICAN INSTITUTE

OF

ELECTRICAL ENGINEERS.

SPECIAL MEETINGS, NOV. 9TH & 15TH, 1887.

SUBJECT:

Recent Improvements in Apparatus for Ocean Cabling.

By CHARLES CUTTRISS.

WITH SUPPLEMENTARY NOTE ON

The Siphon Recorder and Ocean Telegraphy.

By THOMAS P. LOCKWOOD.

NEW YORK CITY:
PUBLISHED BY THE INSTITUTE.
[illegible]

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Copies of the Rules, application blanks, membership lists and general information regarding the Institute may be obtained by addressing the Secretary.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

VOL. V. New York, December, 1887. No. 3.

SECRETARY'S BULLETIN.

In May last a request was issued for the correct addresses and titles of members and associates for the purpose of publishing a complete list. It was not generally complied with, but the directory has been made as correct as possible under the circumstances, and forms a part of the present number. It is to be presumed that all will appreciate the importance of accuracy in such a list, and proposed corrections should be sent in at once.

At the regular monthly meeting of Council, held November 1st, the following named gentlemen were elected to associate membership of the American Institute of Electrical Engineers:

Georges d' Infreville, Electrician, Western Union Telegraph Co., 195 Broadway, New York.

Grosvenor P. Lowrey, Lawyer, 15 Broad street, New York.

Dr. C. E. Zetzsche, of Dresden, Saxony, Telegraph Engineer, Imperial Post Office, Berlin.

Alan D'anvers, Managing Director and Chief Electrician, The Anglo-Portugese Telephone Co., Lisbon, Portugal.

James Hamblet, Proprietor and Manager, Telegraphic Time Service, 195 Broadway, New York.

Andrew L. Riker, Experimentalist and Inventor, 15 East 55th St., New York.

A. L. Rohrer, Electrician, Thomson-Houston Electric Co., Lynn, Mass.

Thomas Bakewell Kerr, Attorney-at-Law, Westinghouse Electric Co., Pittsburgh, Pa.

Charles Cuttriss, Electrician, Commercial Cable Co., 1 Broad St., New York.

Lemuel William Serrell, Assistant Electrician, "C. & C." Motor Co., 90 South Fifth Ave., New York.

Walter A. Giles, Edison United M'f'g Co., 65 Fifth Ave., New York.

Charles Taylor, Assayer and Electrician, U. S. Assay Office, New York.

A. Reckenzaun, of London, England, Civil and Electrical Engineer, 1030 Spruce St., Philadelphia, Pa.

Alfred G. Compton, Professor of Physics, College of New York, 17 Lexington Ave., New York.

William M. Schlesinger, Electrician and Chief Engineer, The Union Electric Co., 4212 Chestnut St., Philadelphia, Pa.

Thomas P. Conant, Electrical Engineer, Electrical Accumulator Co., 44 Broadway, New York.

The following associate members were, upon recommendation of the Board of Examiners, transferred to full membership:

Geo. B. Prescott, Jr., Newark, N. J.	Sidney B. Paine, Boston, Mass.
Lieut. F. Jarvis Patten, Fort Sidney, Neb.	E. Birdsall, New York.
	G. F. Sandt, "
Jo. Stanford Brown, New York.	A. E. Winchester, New York.
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J. F. Porter, St. Louis, Mo.	J. H. Vail, "
Ernest P. Clark, New York.	W. J. Jenks, "
Walter J. Paine, Boston, Mass.	Jerome W. Hyde, Springfield, Mass.

The Index of current electrical literature which begins with the present number is a feature requiring a considerable amount of labor and care, and has been undertaken in response to a very general request from those who have neither time nor opportunity to examine the files of electrical periodicals throughout the world. If readers will call attention to any omission which would render the Index incomplete, it will be inserted the following month.

The next meeting of the Institute will be held on December 6th, at which a paper will be read by William Stanley Jr., Electrician of the Westinghouse Electric Company, on "Phenomena of Retardation due to Alternating Currents." This is a subject of unusual interest at the present time, and Mr. Stanley's researches, which are to be given very fully, will no doubt be heartily appreciated by all who are interested in the distribu ion of electricity.

A special meeting of the Institute will be held on December 20th, at which a paper will be read by Arthur Steuart, Esq., of Baltimore, Md., entitled "Reforms in the Patent System." The National Electric Light Association is making active efforts under the advice of Mr. Steuart for the actual introduction of suitable measures before Congress to effect important changes in our Patent laws. The Institute represents a large constituency interested in this question, and those who cannot attend the December meeting should contribute their views, and use their influence to further the movement. Further particulars of the above meetings will

be given in the notices which will be issued early in December.

The Secretary is frequently called upon for application blanks, and as they are liable to be mislaid, a form has been devised for binding in the monthly Transactions in such a manner that it may readily be detached if required for use.

Sidney F. Shelbourne.

The special meeting announced for November 9th convened under exceedingly depressing circumstances.

Among those who visited the Electrical Exhibition at an early hour was Mr. Sidney F. Shelbourne, one of the charter members, and since May, 1886, one of the managers of the American Institute of Electrical Engineers. In order to more closely inspect the electric lighting machinery, he entered the enclosure where a Trenton engine running at high speed was driving a Mather dynamo. According to the statement of an eye-witness, Mr. Shelbourne, in passing the fly-wheel of the engine, was apparently drawn into it by reason of his clothing catching on the spokes, or possibly by his foot slipping at the edge of the wheel-pit. He was caught by the downward turn of the wheel, carried under, and thrown from the top by centrifugal force, his lifeless body striking against a steam pipe and falling to the floor. His death must have been instantaneous. After taking the necessary steps for the temporary care of his remains, the visiting electricians gradually assembled in the Managers' room, where President Pendleton, of the New York Electrical Society, after a brief announcement of the fatal accident, appointed a committee to prepare suitable resolutions as a tribute to the memory of the deceased, and the meeting was adjourned without day.

Mr. Shelbourne was fifty-one years of age, a graduate of Union and Yale colleges. Although a lawyer by profession, he was naturally scientific in his tastes, and for several years had devoted much labor and thought to electrical branches, more especially the underground problem. The corporation of which he was president, the New York Electric Lines Company, was organized expressly for the purpose of supplying subterranean conductors for the various electrical companies. The franchise secured by this company is believed to have been the first granted by the municipal authorities for conduit privileges in the streets of New York.

As an original claimant for the rights thus obtained, Mr. Shelbourne was vigilant in his efforts to secure what he believed to be the just reward for his foresight and perseverance. Against overwhelming odds, he has persistently but unsuccessfully pressed the attack against what he considered a usurpation of authority by the Commissioners of Electrical Subways.

Mr. Shelbourne has been equally persistent and faithful in his duties as a member and officer of the Institute. When interest in the society has lagged; when at times it has seemed that its vitality was ebbing away; when skeptical adherents doubted its future success; it was then that the vigorous presence of our departed friend stood forth as a conspicuous example of intelligent partisanship, determined and upright in his belief that the field of usefulness open to the Institute was second to none of its character in the world. Although there is a vacant seat in the Council, the cause for which he labored so earnestly has been in a measure upheld by his steadfast example, and those who have been encouraged by his presence, will strive the more arduously to elevate the Institute to that standard so fervently depicted by our late colleague.

Special Meeting, Adjourned from November 9th, 1887.

Held at the House of the American Society of Civil Engineers 127 East 23d Street, November 15, 1887.

The meeting was called to order at 8 P. M., by the President of the Institute, Mr. T. C. Martin.

The President: You are all, no doubt, aware of the sad circumstances which attended our last meeting, of which the present is the adjournment. Before we proceed, therefore, to the regular business of the meeting, I will ask the Secretary to present the resolutions which have been adopted by the Council of the Institute, as a tribute of respect to the memory of Mr. Shelbourne. It may be within the recollection of most of you that Mr. Shelbourne was from the earliest time associated with the Institute, and that during the last two or three years he has taken an active part in its work as a Manager, giving his time and attention and legal ability freely to its service. We miss him very greatly, and as a

member of the Council myself, I can only say that I have very often been greatly encouraged in my work for the Institute, by seeing that which he was at all times willing to undertake in its behalf.

The Secretary then read the following preamble and resolutions, which had been adopted at a special meeting of the Council called at 7:30 P. M.

WHEREAS in the death, by accident, of Sidney F. Shelbourne, the American Institute of Electrical Engineers has sustained a severe loss:

RESOLVED, That we, the members of the Council of the Institute, hereby record our deepest pain and grief at the sudden blow which has deprived the Institute of an active and unwearying Manager, and ourselves of an associate ever prompt to render assistance in the regular work of the Institute and to assume new duties and responsibilities in its behalf.

RESOLVED, That we specially recognize the value of Mr. Shelbourne's services in his revision, as a member of a Committee, of the Institute's rules and regulations, a work performed with the utmost care, discrimination and success.

RESOLVED, That we express hereby our sense of the many estimable characteristics of our friend and associate, exhibited in his work as a Manager of the Institute, his energy, his courtesy, and his persistence in what he deemed for the best interest of the body, and most likely to promote, through it, the welfare of the electrical profession.

RESOLVED, That these resolutions be spread on the minutes of the Council, and be printed in the Transactions of the Institute.

THE PRESIDENT: At the meeting at the Electrical Exhibition a committee was appointed by Mr. Pendleton, the President of the New York Electrical Society and the chairman of the meeting, to draw up resolutions with reference to the untimely death of Mr. Shelbourne. The Committee will now please report.

MR. HAMBLET, Chairman of the Committee, read the following resolutions and moved their adoption:

WHEREAS, The members in joint meeting of the New York Electrical Society and the American Institute of Electrical Engineers, learning of the sudden death of their associate and comrade, Sidney F. Shelbourne, at the moment of their assembly, which, being communicated by the Chairman, brought a resolution for immediate adjournment in view of the calamity, and the appointment of a committee to draft resolutions appropriate as an expression of their grief at this loss, as well as a means of conveying a tribute to the memory of the deceased:

RESOLVED, That in recording the death of our valued associate, Sidney F. Shelbourne, we desire to pay a tribute to his personal worth and good qualities, as seen both in his friendly relationship with the Society and in his services as a member and officer of the Institute. We deeply regret and deplore the calamity of his untimely and accidental death, depriving us and the electrical profession of an earnest worker, always willing, upright, genial and considerate in his connection with us.

The resolutions were unanimously adopted.

THE PRESIDENT: The resolutions will accordingly be entered in the Transactions of the Institute, and a copy will, as requested, be forwarded to the Electrical Society.

The subject before us this evening is one of the greatest interest and will be presented to us by a gentleman whom we all recognize as foremost in his profession in this country. It deals with recent improvements in apparatus for ocean telegraphy, and I have great pleasure in requesting Mr. Cuttriss to proceed with the reading of his paper.

RECENT IMPROVEMENTS IN APPARATUS FOR OCEAN CABLING.

BY CHARLES CUTTRISS.

In order that the improvements embodied in the instrument you may have seen at the American Institute Electrical Exhibition may be clearly appreciated, it would be well, perhaps, if I were to mention briefly the instruments previously used on the Atlantic and other long submarine cables.

The mirror galvanometer was undoubtedly the first commercially successful instrument ever used on an Atlantic cable, and you are all so familiar with it as a measuring instrument that a description will be superfluous, but perhaps it will be well to point out its defects as an instrument by which messages are received: Firstly, it requires two operators to work it, one to call out the signals, the other to write them down. At a first glance there would not seem to be much room for errors on the part of the *writer;* as the operator is called who writes the message letter for letter from the other's dictation; but you will see that they *can* easily be made when your attention has been drawn to the similarity in sound between "B," "P," "V," "M," "N," and other letters when rapidly called out. This similarity, of course depends largely upon the more or less clear enunciation of the speaker. The liability to misunderstand a letter on the part of the writer tells severely against the *rapidity* of the service as well as its accuracy, for this reason: supposing the writer misses a letter in a code message; he has no possible way of telling from the context what it should be; he cannot interrupt the receiver to ask him to repeat it, therefore his only course is to omit it and trust to his reader's recollection of the particular word at the end of the message. If he should not remember it, they must then delay the traffic by getting the word repeated from the distant station.

In order to avoid this liability to misunderstand one another, some operators get into the way of calling out the letter and immediately following it with some short word whose initial

letter would correspond with the one called out, such as "n" for "nuts," "m" for "mutton," etc.

Another cause for delay arose from the fact that some readers would never trust to the correctness of their writer, but would always stop at the end of a message to scan it over in order, if possible, to detect any error that might have been made. While all these things added to the delay in transmission, one can hardly blame the clerks; for if an error was discovered at headquarters it meant a fine of $\frac{1}{8}$, $\frac{1}{4}$ or $\frac{1}{2}$ a day's pay, in which all three of the clerks—the transmitter, receiver and writer—had to participate. It was impossible to lay it at the door of any particular one, as each of them would most emphatically deny the soft impeachment of the possibility of *his* making an error.

These causes of delay are now obviated by the use of the recorder, as the operator can always take a second glance at any doubtful signal. Were it not for this liability to error on the part of the mirror clerks, I doubt if that instrument would have been so entirely superseded by the recorder, for its simplicity is a great recommendation. It requires very little skill in its adjustment, and with clerks that work well together, its speed is as great, if not slightly greater, than that of the old form of recorder.

During the years 1868 and 1869, while I was in Sir William Thomson's laboratory at Glasgow University, his first siphon recorder was constructed. I well remember the instrument, the electro-magnet of which was a ring of iron about 1 foot in diameter; 1 inch thick and 7 inches deep. The signal coil was rectangular in shape, about $6\frac{1}{2}$ inches long by 2 inches wide. The electro-motor for drawing the paper slip was an ordinary 5 or 7 armatured wheel with two electro-magnets. It was provided with two bands, one of which turned some wheelwork, which drew the paper slip, while the other rapidly revolved a small generator or replenisher which produced by induction, static electricity for maintaining the electrification of the ink. This replenisher worked on the same principle as those used for maintaining the potential of the Leyden jar of Sir William's quadrant electrometer. The whole arrangement looked like a medley of different instruments selected at random from a laboratory supply; yet each had its different part to perform, and it was wonderful to see the results that were obtained, when they were working harmoniously together under the direction of the masterly mind of the man who

organized them, and who stands peerless either as an inventor, a scientist or patient instructor.

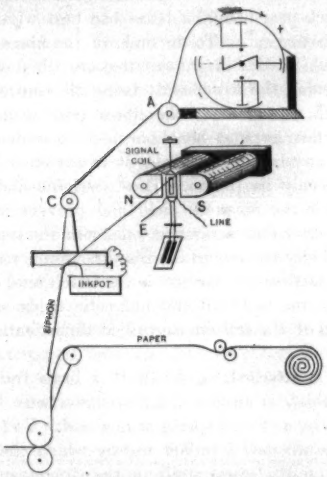


DIAGRAM OF THE THOMSON SIPHON RECORDER.

Some three years later, one of the most improved recorders was sent out to the cable station at Duxbury, Mass., and as you may not be acquainted with its construction I will describe it briefly, in order that you may more readily understand the changes that have been made in it up to the present time.

The upper part of the diagram represents the "mouse mill," as it is commonly called, which generates the static electricity that is conducted from the drum A containing a coiled spring, along the moist string and thin wire which you see stretched fom *A* to *E;* the ink-pot is supported on a baked wood arm and is metallically connected with the frame to which the siphon is suspended, this in turn being connected with the milled nut *C*. *N* and *S* are the respective poles of a strong electro or permanent magnet, between which is seen an oblong piece of soft iron, the purpose of which is to concentrate the magnetic lines of force into two fields, through which the two sides of the rectangular signal coil pass. The signal coil which is connected to the cable is suspended by fine silk cord, and care is taken that it hangs

perfectly clear from all the iron of the magnetic circuit. Attached to the bottom of the signal coil will be seen two strong silk fibres which pass behind a brass bar, into which a series of shallow notches are cut. To the ends of the fibres are attached lead weights which slide in grooves that are tilted slightly out of the perpendicular, the lower ends being the nearest to the observer; by this arrangement the fibres pass at a slight angle partly around the serrated brass bar, and consequently are held securely from any lateral displacement in any one of the notches in which they may be placed. These weights and fibres hold the signal coil in the magnetic field and prevent its moving in any direction other than a circular one, with the suspension cord as an axis, and any movement in this direction is resisted by the two fibres supporting the lead weights, which tend constantly to keep the coil in the centre of the magnetic fields, and therefore the movements of the coil are controlled almost entirely by these fibres.

The siphon is attached, as shown, to a brass frame, from the bent ends of which is stretched a fine brass wire kept under a constant strain by a curved spring at one end. To the other end of the spring is attached a milled nut by which the wire can be twisted so as to put a lateral strain on the siphon and its carrier. A small lug projects from this carrier and to it is attached the fibre the other end of which is fastened to one corner of the signal coil. The signal coil is now twisted slightly in a direction such as to draw the fibre, and with it the siphon, away from the observer. If now the milled head on the brass frame is turned so as to bring the end of the siphon again toward the observer, and into the centre of the paper slip which passes in front of its lower point, every motion of the signal coil must be followed by the siphon; and as the fibre is attached so near the strained brass wire the movements of the signal coil will be greatly multiplied.

The marking of the siphon is done as follows: The mouse-mill generates, static electricity, which, being conducted along the string and wire from *A* to *C* electrifies the ink contained in the ink-pot, and as the ink-pot is insulated, the only way that the electricity can escape is by means of the column of ink contained in the siphon. It does not discharge as is commonly supposed across the air space between the siphon point and the moving paper slip, but the electrified ink draws the siphon which contains it bodily toward the paper (which is slightly damp) until

they touch, when the siphon is immediately discharged to earth, and by its elasticity flies back to its former position, by which time a sufficient charge of electricity has accumulated to again attract it to the paper. These movements to and from the face of the paper, which are termed the "vibration," take place at a speed determined by the natural rate of vibration of the siphon, which is generally between 80 and 100 per second; hence we can obtain a record of the potential of the cable as many as 80 times a second; and as these potentials are determined by the operator sending at the distant station they constitute the signals at the receiving stations.

The arrangement adopted in this instrument to regulate the supply of static electricity to the ink-pot was by interposing a piece of moist string between the spring drum *A* and the milled head *C*. This string had a fine wire attached to one end, so that by turning the milled head in one direction the length of the moist string interposed between the two points could be varied and likewise the electric discharge to the ink-pot.

This arrangement worked very well at Glasgow, where the atmosphere is to a great extent saturated with moisture; but in this country the string was soon dry, and then the ink would not be electrified, and consequently the record would fail. To remedy this defect I made use of the brush discharge by connecting an adjustable wire provided with a sharp point to the drum *A*, and a flat piece of brass to the milled head *C*. This was found to work perfectly, and that principle has been adopted in all electrified ink receivers made since that date. But we soon began to experience a greater trouble than the one before spoken of, and one that still exists in all recorders using static electricity as a means of vibrating the siphon; that is, the great difficulty experienced in generating a supply of static electricity during damp weather, and in keeping the arm that supports the ink-pot dry. Everything will work beautifully in nice, fine weather, but during the moist, clammy dog-days of August, and the foggy days that are liable to come on at most cable stations without a moment's warning—then it is that trouble of the most aggravating description falls upon us. Suddenly the record fails. Examination shows that the generator or supporting arm of the ink-pot has become damp. Lamps are lighted and placed near the instrument, *sometimes* with a satisfactory effect, but oftentimes not. In the latter case there is no remedy but to stop working the recorder and go

over to the mirror instrument while the generator is being dismounted and thoroughly dried; but meanwhile valuable time has been lost, and business has been delayed.

Everything imaginable was tried in order to overcome this difficulty, but without success, and at last we realized that in order to make the instrument more reliable, we must find some way of obtaining a record without depending upon the electrification of the ink.

The first suggestion came from Mr. John Gott, the superintendent of the St. Pierre station, namely, to make the siphon a shade larger than usual, and put a few camel hairs in the tube at its marking point, and, as it were, paint the record on the paper slip. This worked very well, but the siphons would occasionally clog up, as we were at that time using commercial writing ink. The hairs acting as a strainer would arrest the larger particles. When you realize the smallness of the tube, the bore of which is only $\frac{1}{700}$ of an inch in diameter, the wonder is *not* that it got clogged up, but that the ink would flow through it all. The next step in advance was taken one day when the hairs accidentally came out of a siphon, the point of which happened to be particularly smooth and square with the paper; it was then found that a very good and reliable record was made by carefully adjusting the paper up to the point of the siphon until it touched it. The paper was then drawn slightly backward again; the capillary attraction being sufficient to keep the siphon from leaving it, while at the same time the friction was greatly reduced. This manner of recording has been used ever since that day on the "Dy" section of the "69" cable, and it has also been adopted on many others whose length does not exceed 1,000 miles, but they must have a conductor of low resistance.

About the year 1876, I constructed a recorder of the most simple kind, in which the signal coil was pivoted and to which the siphon was directly attached. The controlling springs or fibres were dispensed with by attaching a small piece of iron to one corner of the coil and bringing it under the influence of another movable piece of iron on one of the pole pieces of the electro-magnet. It was during the construction of this instrument that I was endeavoring to vibrate the siphon mechanically and also by means of magnetism, but at that time I did not succeed in getting a perfectly straight and steady line. As the mode of working before described was so satisfactory, I did not pursue my

experiments any further, for inasmuch as I had eliminated the troubles incident to the use of electrified ink at the Duxbury station, I did not realize that they still existed at other stations where the methods we adopted could not be practiced, owing to the greater length of the cable. However, Mr. Dickenson, of Heart's Content, N. F., was not idle, and during the year 1885 he invented and patented a method of vibrating the siphon mechanically. The method practiced by him was to prolong the cradle carrying the siphon. He then attached a magnet and armature at the end of the frame carrying the strained wire, and connected the prolongation of the cradle to the armature by a silk fibre. When a battery is connected to the magnet and its circuit is rapidly interrupted, the motion of the armature is communicated to the siphon by means of the connecting fibre. What success this invention has met with in practice I am unable to state.

When I became identified with the Commercial Cable Company, I found that it was decided to prolong their ocean cable, which landed at Coney Island, into the heart of this city by means of an underground cable, and to use a recording instrument upon it. The type of cable and the high rate of speed at which it was to be worked required that the instruments should be of the most sensitive class, hence electrification of the ink or some other device for preventing friction between the siphon and the paper slip must be used. Therefore, as nothing else offered we adopted the electrified ink recorder. It was not long before the old troubles were encountered, as the office was very small, and we were obliged to keep the windows open for ventilation. Consequently it would be only a short time after a rain storm began before I heard the old cry, "the ink has failed." This was such a constant source of trouble that I determined to try again and find some other way of vibrating the siphon. After mature thought, and with the experience gained from previous failures, I was convinced that, in order to make any device work successfully and still leave the instrument as sensitive as by the use of electrified ink, the siphon must hang perfectly free and not be retarded in its lateral movements by any extraneous fibres, and that, at the instant it touched the paper to leave its dot of ink, the point must be locked, as it were, to prevent its rebounding laterally, in case the surface of the paper should be slightly irregular. The only resource seemed to be magnetism applied as nearly as possible in the same manner as had previously been practiced with

electricity. I determined therefore that the part of the siphon under its influence must be the marking point. The question then arose in my mind as to the possibility of attaching a sufficiently large piece of iron to the end of the siphon without weighting it to a degree that would be detrimental to the clearness of the signals, by reason of its increased inertia. Another very doubtful point was, would it be possible to construct a magnet with a field of force so uniform that a siphon tipped with iron would vibrate at right angles to the plane of its polar face without any tendency to irregular lateral movements, or in other words, if it were placed near the edge of the magnet, would it not have a tendency to be drawn toward the centre? When the idea was first conceived, I must admit that I had the greatest doubts of its success. But nevertheless I determined to give it a trial, so I attached a toothed wheel to the shaft of an electro-motor, so as to act as a contact breaker for the local circuit, containing the electro-magnet with which it was desired to vibrate the siphon which had its point armed with a small piece of iron, and was attached to the usual strained wire suspension of a recorder, held firmly in a vice on the same table upon which the motor was running. The siphon was now approached by the rapidly vitalized electro-magnet, but without its showing any signs of vibration. Thinking that perhaps the battery was not strong enough to energize the electro-magnet sufficiently, more was added to the circuit, but still without effect. I then removed the electro-magnet, intending to replace it with a more powerful one, but the motor was still running; so imagine my surprise the next time I looked toward the table, when I saw the siphon vibrating beautifully, describing an arc of about half an inch.

Thus without any apparent cause it was doing by itself what I had vainly endeavored to *make* it do with a powerful electro-magnet. However, the solution of the mystery was soon arrived at, as I accidentally touched the table and felt a very slight but regular vibration, then everything was clear and I saw that the motor put the table into a state of vibration, the rate of which was exactly equal to that of the natural rate of the siphon; which, therefore, picked up the vibrations and showed them in a greatly magnified form. I realized plainly from this experiment that to make the siphon vibrate by magnetism all that was necessary was to vitalize the magnet at a rate equal to the natural period of the siphon. In a short time, by means of a second experiment, I

succeeded in producing these vibrations by magnetism and found them just as regular at the edge as at the centre of the magnet, the siphon not having the slightest tendency to move laterally from any position in which it was placed.

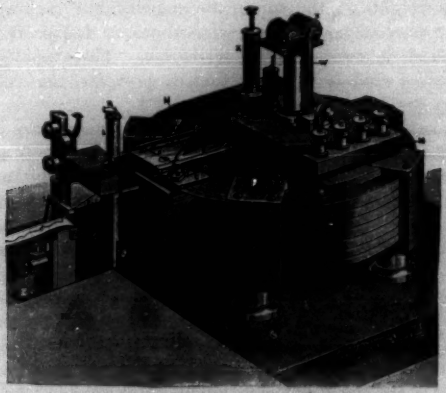
It would be uninteresting to you to follow me through all the numerous experiments that were made before the vibrator was perfected. But I will mention one instance that shows how simple may be the cure for the unforseen difficulties that constantly arise when one is trying to perfect an instrument. When the first vibrator was tried, in which the mercury was used to alter its rate, it was noticed that the record would fail with great regularity for about an inch. The trouble was located in the glass tube, and was due to some of the mercury climbing up it under the influence of the vibration and then falling back to the main body. This, of course, made variations in the rate, and was fatal to the instrument unless it could be remedied. I tried putting weights on the top of the mercury, but they would not work satisfactorily, and at last, when almost in despair, the remedy was found in two drops of glycerine. The viscosity of the glycerine, I find is so great that it prevents the column of mercury breaking up.

This method of vibrating the siphon by magnetism has been applied to all the Thomson recorders in use on the Commercial Cable Company's system for upwards of a year with the greatest success. Failures of the ink are now almost unheard of, and the recorder, so far as ink failures are concerned, could, if necessary, be worked under a shed during a rainstorm or fog, as well as though it were in a warm room.

In all the Thomson recorders that I have seen, the movements of the signal coil are controlled by the lead weights before spoken of, and the clearness of definition and shape of the signals depend almost entirely upon the adjustment of the fibres which are attached to the signal coil and support these weights. In practice more or less trouble is found in maintaining such an adjustment as will give the best shaped signal. This is owing to the dust which collects upon the weights, wedging them fast in the grooves. Consequently any change of temperature, or humidity of the air, will alter the tension on one or both of the fibres, and thus oftentimes render the signals unreadable. So much trouble was experienced from this cause at our Canso station that it led the superintendent, Mr. S. S. Dickenson (who was ably seconded

by Mr. J. C. Upham, the mechanician), to devise an adjustment in which the weights were discarded and a spring used in their place. The fibres could also be spread to any desired extent, and as the strain on both of them was exactly the same, the signal coil was always in a truly central position in the magnetic field.

Since this improvement has been applied to the instruments the adjustment has rarely been changed, and, what is of still greater value, a decided increase of speed has been effected. With the exception of these recorders, it is always necessary to stop work when it is desired to make any change in the adjustment of the controlling fibres, as they are very inaccessible. This, together with their occasionally breaking, led me to try and construct an instrument in which these difficulties would be removed. The result has been the instrument now on exhibition at the American Institute.



THE CUTTRISS SIPHON RECORDER.

The siphon P is a fine glass tube about one hundredth of an inch diameter, one end of which writes upon the paper slip J and has attached to its point a piece of No. 30 iron wire about one-eighth of an inch long, which serves as an armature and is controlled by the impulses of the magnetic table T over which the paper slip passes. The impulses of the magnetic table are controlled by the vibrator, which is placed on the large permanent

magnets *M M*, and consists of a glass tube *W* which is connected by a tube of india-rubber to the mercury reservoir *X*. The glass tube is supported by a steel rod carrying a spring contact point *V*, and carries an armature, seen opposite the poles of the small electro-magnet *Z*. When a battery of three or four gravity cells is connected to the terminals 1 and 4, the glass commences to vibrate at a rate determined by the height of the column of mercury in the glass tube *W*, the height of which can be regulated by turning the milled thumbscrew at the top of the mercury reservoir which connects with a plunger within the latter.

From the terminals 2 and 3, two wires connect to the electro-magnet of the magnetic table *T*. Thus every time the contacts at *V* are closed the table is energized and the siphon is drawn down to the face of the paper by the attraction of the magnetic table for the small piece of iron which is attached to the point of the siphon. If the impulses given to the siphon are in accordance with its natural rate of vibration a succession of fine dots of ink will be left on the paper in a perfectly straight line so long as the siphon is not moved laterally by the coil *R* and a supply of ink is maintained in the ink-pot *Q*. Should the impulses given to the siphon by the vibrator not be in accordance with the natural rate of vibration of the siphon, it will not vibrate and the record will fail. But by manipulating the plunger in the tube *X*, the height of the column of mercury *W* is varied, so that the rate of the impulses can be maintained anywhere between 60 and 100 per second. Hence any siphon that would be suitable for the instrument can be controlled, as its rate will lie within these limits. When the proper height of the mercury has been once determined, which is generally found in less than half a minute, the siphon will continue to vibrate until it is broken or removed for other causes.

The signal coil *R*, which is moved by the currents transmitted from the distant station, is pivoted at the bottom and top *B* in agate bearings, and is free to move in the annular space between the poles of the permanent magnet *M*. On the top of the coil there is attached an aluminum extension *E*, which has a narrow slot at its upper end through which passes the regulating fibre *D'*, one end of which is attached to the rigid support *O*, the other end being fastened to a flexible spring *F*. The strain on this spring and this fibre is regulated by moving the index *G'* and signal coil *R*. Close to the point *E* and at right angle to the fibre *L'* there is another fibre *D*, one end of which is attached to an exceedingly

delicate spring *F*, the other end is fastened to an extension from a fine brass wire contained in the tube *L*, to which the siphon is secured. The upper end of this strained wire is attached to the thumbscrew *K*, so that by turning the latter the siphon can be moved laterally over the face of the paper to any required position.

Thus it will be seen that if the siphon is moved off the paper slip toward the front of the instrument when the fibre *D* is strained by moving the spring *F* outwardly, the siphon can be pulled by it into a position over the centre of the paper; the torsion on the strained wire and the strain on the spring, now balance each other, and if the two cross fibres are fastened together at a point as near as possible to the extension *E*, any movement of the coil will be multiplied and transmitted by means of the fibre *D* to the siphon. By lifting the fibres out of the slot *E* and turning the coil toward the front of the instrument, the coil and part of the pole piece *C* can be removed from the instrument without disturbing any other part, and, when replaced, no readjustment will be necessary.

It has been suggested to me that pivoting the coil was a step backward, as it introduced friction, and would mar the definiteness of the signals. I can only say, in reply, that when the instrument is adjusted, and giving good signals at a rate of 30 words per minute, I cannot detect the slightest friction. If I deflect the siphon laterally only the width of a hair it immediately, on its release, returns accurately to zero, which it certainly would not do if there was any friction worth speaking of in the pivots.

I have received good signals on this instrument at a speed of 30 five-letter words per minute, over our New York-Canso cable, which has a length of 980 miles, capacity of 231 microfarads and copper resistance of 13,680 ohms.

I do not intend to stop at this speed, but think that with the next instrument, in which some of the parts will be slightly modified, a speed of 25 or 26 code words a minute will be attained over our long sections, which have a length of 2,740 miles, capacity 874 microfarads and copper resistance 6,967 ohms.

I will not take up much more of your time this evening, but as the title of this paper is so broad I am loath to leave the subject without mentioning the great advance that has been made during the last few years in the working of the Morse system on cables.

Before the year 1879 no section of the Atlantic cables had been worked by any other method than mirror or recorder. That the Morse *has* been successfully introduced on two sections is due to the determination and persistence of Mr. G. G. Ward, of this city, at whose request Mr. T. J. Wilmot, now superintendent at Waterville, Ireland, applied himself day and night to the task of originating a translating device by which, in the year 1879, Torbay, in Nova Scotia, was put in direct communication with New York.

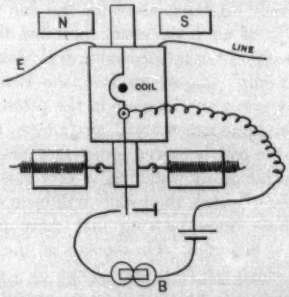


DIAGRAM OF THE ALLEN AND BROWN RELAY.

This same device, in which the Allen and Brown relay is used as a receiving instrument on the cable circuit, is now worked on our Rockport and "Cs" section. The difficulties that were surmounted will be better appreciated when I mention that the length of cable in circuit is 610 miles, with an inductive capacity of 168 microfarads, and a copper resistance of 8 482 ohms. The total circuit, inclusive of the land line, is 942 miles.

The Allen and Brown relay consists of a coil through which passes a soft iron core. The ends of the core project into the magnetic field produced by the permanent magnets *N S*, and are consequently polarized by them. In the diagram, the mark in the centre of the rectangle represents the axis of the coil. If, now, we connect the coil to the cable circuit and have two fixed contact points for the local circuit, as in an ordinary relay, the first impulse, or say the letter "S," which consists of three dots, will close the local circuit; but as the cable does not lose its charge rapidly, as is the case with a land line, the coil will not return to the back-stop and be ready to close the circuit again with the second impulse of the letter, but will be held fast to the front

contact, keeping the sounder closed all the time. This, of course, will prevent any more signals being received over a cable, and some means had to be found by which the armature tongue would open the circuit whenever the potential of the cable fell ever so slightly from its maximum. This was accomplished by allowing the armature tongue, which is called the "jockey," to have a movement around an axis of its own. It was therefore pivoted, as shown, slightly in advance of the axis of the coil; you will now see that if the two points which control the local circuit are adjusted very closely together, allowing the end of the jockey a play of only $\frac{1}{1000}$ of an inch, every time that the coil falls back toward its centre position (after having been deflected by the receiving current) only $\frac{1}{1000}$ of an inch, the local circuit will be opened, and *vice versa* any increase in the potential sufficient to move the coil the same amount will again close the local circuit. By this means the coil is moved sometimes considerably in one direction, and although by watching it very closely no backward movement can be detected, the jockey will open the circuit, sometimes two or three times, proving that there have been corresponding falls in potential. On the axis of the jockey is a very delicate spring which can be pressed down by a small nut so that just sufficient friction is maintained on its jockey to enable it to close the local circuit firmly enough to pass the signals to the local circuit.

Some few changes have been made in the jockey of the relay by the superintendents at the terminal cable stations—Mr. Dickenson at "Cs" and Mr. R. Hearn at Rockport—until at last such perfection has been arrived at that the signals are passed from Canso to New York in such a perfect manner that none but an expert could tell that there was any cable in the circuit. This is, I believe, the longest section of cable on which the Morse system is worked, and, although repeated efforts have been made to attain the same results on a cable only about 100 miles longer, the retardation was so severe that the speed attained was too low to allow this system to be adopted. Gentlemen, I thank you for the patience with which you have listened to me this evening and I regret that time will not allow me to touch on several other interesting branches of investigation, such as curb sending, the duplex, automatic transmission, etc. But the object of this paper will have been attained if you realize that, although seldom heard from, there *are* many patient investigators in our remote cable sta-

tions, and that to their unflagging energy is due the fact that we are now easily able to handle a bulk of business that would have staggered us a few years ago, and do it with so little delay that a message can be sent from New York and delivered in London in less time than you can send one from down-town to Harlem.

Mr. Pendleton here took the chair and stated that Mr. Martin would read a paper contributed to the discussion by Mr. Lockwood.

Mr. Martin then read the following paper:

Supplementary Note on the Siphon Recorder and Cable Telephony.

BY THOMAS D. LOCKWOOD.

As some of you are aware, I was present at the time and place appointed for our meeting, to hear Mr. Cuttriss explain and describe the improvements he has effected in the siphon recorder.

Although the unfortunate accident which we all deplore deprived us of the pleasure of hearing Mr. Cuttriss at that time, and myself perhaps for all time, still I congratulate myself that my visit to New York has at least given me a personal knowledge which I had never before possessed, of that beautiful instrument, the siphon recorder. I have acquired a new illustration of the impossibility of obtaining an accurate knowledge of the construction and operation of a delicate piece of electrical apparatus from text-books. I had studied the siphon recorder in books, but found myself ignorant of it when the opportunity of examination at length presented itself.

It was especially gratifying to me to learn that we were to hear about an important branch of telegraphy, for I think that telegraphy has been of late neglected.

Though I yield to no man, in my admiration for the immense recent amplification of the work of electricity, or in my appreciation of motors, lighting apparatus and heavy currents, I love variety, and have found it somewhat palling to read and hear as much about them as I have had to of late; for just as the human stomach quails at the idea of eating quail more than forty meals in succession, so the human mind revolts at the notion of considering electrical currents due to an E. M. F. of from 600 to

1000 volts perpetually; and longs to demi-volt once in a while. Therefore, I hailed with joy the announcement that we were to hear about the siphon recorder.

I learned that Mr. Cuttriss's recorder was operated by a permanent magnet instead of an electro-magnet. That is an advance which appeals strongly to me; and it means, as I look at it, a considerable diminution in the amount of attendance required. When I consider the number of telephones in use now, and reflect what a number of cells of battery would have been required, had it not been discovered that permanent magnets could be utilized, and that the use of the battery was chiefly to make the magnetism, I cannot but appreciate that this is a material advance step.

Then let us look a little further; I understand from the text-books that on long cables it was found that, if the siphon end were allowed to touch the paper, the freedom of its movements was interfered with, and that it was therefore found necessary to oppositely electrify the ink and the paper, the former being thus caused to issue and to mark the paper in a succession of fine dots.

If I understand the instrument of Mr. Cuttriss, it dispenses with this feature, which must have often marred the usefulness of the recorder, since on our eastern coast the atmosphere is usually rather "hygroscopic." I can well imagine occasions when all the ability of the operators and electricians must have been called into play to get the electrifying machine—the "mousemill," I believe, to work—in places and at times when the air was surcharged with moisture, and the "relative humidity," as the Signal Service calls it, was up in the nineties per cent.

It is interesting to note with Prescott, that while the telegraph of the United States, the Morse, which made its proud boast that it was a recorder, (and by the way the first recorder,) has now almost totally been transformed into an acoustic or aural transient signal; the Cook and Wheatstone telegraphic idea, the visual semaphore, has evolved into the wonderfully delicate recorder before us.

I am also desirous of calling the attention of the Institute to the fact recorded in a letter of Mr. John Gott, dated St. Pierre, Miquelon, March 24th, 1887, to the Society of Telegraph Engineers, that the siphon recorder was capable of transmitting and reproducing speech telephonically, and that Mr. Gott had actually

used it as a telephone. As I think this circumstance deserves a wider recognition, I will quote certain portions of the communication.

Mr. Gott says:—"With the object of stimulating inquiry into the means of improving the telephone of Mr. Bell, which is the most beautiful adaptation of telegraphy ever made, I desire to draw attention to a few simple methods by which any one may satisfy himself of its practicability, for no one having witnessed its performance can fail to see a great future before it. The recorder of Sir William Thomson affords a ready means of speaking, and gives out such clear tones as to make the listener at first involuntarily look for the speaker behind the instrument (who may be miles away). It suffices to take a tube two inches in diameter, and stretch over one end a membrane of parchment or thin gutta-percha (the latter is less affected by the breath, the former becoming somewhat flaccid after a time). To the centre of the membrane cement a straw, and fix the tube in front of the instrument; about six inches from the movable coil, cement the other end of the straw to the coil at the point where the silk fibre is usually fixed; this is all that is necessary for both speaking and receiving. Six or eight cells on the electro-magnets suffice.

"A pair of these tubes may also be connected in a similar manner with the tongues of the two polarized relays. The tube is to be fixed in a convenient position at right angles to the tongue, taking care that the latter is free from its ordinary contact points. No battery is required for speaking with this arrangement. Or a pair of these speaking tubes may be connected with the ordinary armatures of any instruments or relay, and a current kept on the line.

"By these simple means—may be demonstrated the possibility of speaking over many miles of telegraph line. The sound in the tube is not that of a whisper but of a voice at a distance; I have spoken through four knots of buried cable without sensible diminution of effect."

Since writing the forgoing it has been suggested to me that I might say a few words on the possibility, or possible practicability, of telephonic transmission over long submarine cables.

There is, I think, little to say on this head. You are all aware that in telegraphy it has been found possible to clear cables of charge by sending after each impulse of definite direction, a clearing impulse of opposite direction by which the static charge of the conductor was neutralized and the line cleared for the transmission of a second signal.

The first idea regarding the transmission of telephonic or voice currents over submarine cables, is in favor of its practicability; for it may be argued, since the foregoing practice aids the trans-

mission of telegraphic signals, and since telephonic currents, as usually transmitted, consist of a series of rapid alternations, why have we not here just the conditions of success.

The truth is we have not. For in telephony the changes occurring are infinitely *too* rapid. They cannot serve the purpose of clearing the line; they rather serve the purpose of blocking the line, for the successive and consecutive impulses of opposing direction, succeed one another so swiftly that they practically neutralize one another.

Take for example the magneto telephone. It is well known that the currents generated by this instrument when used as a transmitter are alternating, and follow one another with extreme rapidity. So that for a long time it was thought that they were so infinitesimal as to be immeasureable.

Suppose we have a fine galvanometer, and telephone through it. We see no deflection, but not because the current is so small, but because the plus currents succeed the minus currents of like potential and strength so fast that the needle cannot respond, and therefore does the next best thing and stays at zero.

Let us now consider the battery transmitter and induction coil. A moment's consideration will show us that we have a close analogue to the operation of the magneto telephone.

For though it is true that in the battery transmitter the action of the diaphragm merely varies the resistance of the circuit; and consequently the *strength of current correspondently but in inverse* ratio, yet it is none the less true that the use of the induction coil, develops currents in the secondary circuit and line which are alternating, because caused by the successive rise and fall of current in the primary circuit.

Consequently these currents are subject for long circuits of high capacity to the same drawbacks as those of the magneto telephone. We have then at present only one other alternative method, namely the plan of including the battery and transmitter in the main line, and allowing the transmitter to vary a permanent current flowing in the main line, thus dispensing altogether with the coil. But this also is impracticable, because the very small proportion of variation in the total resistance of such a circuit, cannot develop fluctuations of sufficient strength to satisfactorily influence a receiving instrument.

I am therefore convinced that electric telephony—that is the transmission and reproduction of the human voice—will not, at

least in the near future, be possible over long cables.

Electro-static induction and the retardation and prolongation resulting therefrom is the reason.

When I say *long* cables, I mean for example those over 100 miles long; and it would be difficult and not commercially successful over much shorter distances.

My conviction is that, those who advertise the operation of telephones over Atlantic cables, either do not know what they are talking about; or knowing, wilfully make misstatements for prospective personal gain. I am very sorry that I cannot be present to hear Mr. Cuttriss, and the discussion of the subject, but will certainly enjoy reading it afterwards.

Discussion.

The President:—Gentlemen, you have heard the paper of Mr. Cuttriss and Mr. Lockwood's somewhat informal comments thereon, and it is now open for discussion. I will take the opportunity of saying that should there be any gentlemen present who are not members of the Institute we should be very glad to hear from them should they wish to elicit any points, or in case they may be able to give us information with regard to the subject now before us.

Mr. Joseph Wetzler:—I would like to hear from Mr. Cuttriss as to what his experience has been in telephoning over cables.

Mr. Cuttriss:—My experience in trying to telephone over cables commenced, I think, the same year, or at any rate the year after the telephone was brought out by Professor Bell. I was then at Duxbury. The late Mr. Gower, whom I presume most of you know of, came down there with the best telephones made, up to that date, to try and speak over the Duxbury cable. He also brought down with him his electric harp, as he termed it, which was a series of reeds that could be struck by hammers the same as in a pianoforte, which would vibrate the contact points underneath the reeds and send of course the same number of vibrations into the line to which the reed was tuned; and it was his desire to put that on the cable and have the superintendent, Mr. Gott, at St. Pierre, listen at the telephone for any sounds. He evidently, at that early date, appreciated the fact that it would be easier to get an intermittent current over a cable than it would be to get speech over it. We listened, and Mr. Gott reported nothing. He tried varying his power to the limits to which we allowed him to

go, but still Mr. Gott reported there was nothing. We then asked Mr. Gott at his end to send intermittent currents into the cable, through condensers and also without condensers. These were from a key. Nothing was heard; it was absolute death in the telephone. Mr Gower would not believe, nor could we convince him, that the telephone was properly connected with the cable; so to prove it I connected his telephone in circuit with the recorder and instructed the party at the other end to send regular telegraphic signals into the cable. By this means they must come through the telephone and on their way to earth also pass through the recorder. If the signals came, we must see them. The consequence was, every signal came out written perfectly on the recorder, which we all read; but still it was death in the telephone —not a symptom of a sound. Still Mr. Gower was doubtful and I did not know what to do. He did not like to doubt us, and yet we could see that he *was* doubtful. At last it struck me that I would put a rapid rheotome in the circuit with the telephone. Now, if there is any current coming over the cable at all, although it is infinitely weak when it is received at the receiving station, this rapid make-and-break would vary it so much as to certainly make it audible in a telephone. The next time the signals were transmitted over the cable, the make-and-break being started, the room was filled with the sound of the pitch of the note that the make-and-break took, showing that the cable current was all the time passing through the telephone; but its wave was so slow and so even that although the diaphragm responded to every one, it was totally beneath the capacity of any human ear to take the waves up and hear them as sound. Of course you will all readily understand that sending not probably more than 100 signals in the circuit at the time, the vibrations coming in waves of that period would not be audible, because no ear can take up sound at that rate. That has been my experience. We have tried it over our cables here in New York for several parties, and we have also conducted experiments for Professor Farmer, within the last year, over our Rockport cable, to see if we could get any sounds in that way. But in every case it is absolute death, and the greatest distance at which I have heard signals on a telephone has been through about 75 miles of artificial cable.

THE PRESIDENT:—This cable subject is one that is not comparatively new to most of us in America, but somewhat unfamiliar. In America we have made so much progress in all the other

departments of electrical application that we seem to have left that of cabling to our European, more particularly our British brethren, as a sort of consolation cup. And they have certainly made remarkable progress in that field and can in that respect and in that department set us an example. We have with us this evening one or two gentlemen who are quite prominently identified with some of these departments of work, and there is one gentleman here that, could he be induced, I would like very much to address the meeting. He is not altogether a stranger in this city and is certainly very well known to every one who has had anything to do with cabling. I refer to Captain Trott of the cable repairing steamer *Minia*, which happens to be in port at the present time. (Applause). Captain Trott is a very reticent man, but if we could once get him started he would give us such a wealth of information that it would take a good deal of time to digest it. Captain Trott, it will afford us extreme pleasure to hear from you this evening.

CAPTAIN TROTT:—Your President has intimated that Captain Trott is rather reticent. That is not altogether Captain Trott's fault. We belong to an old telegraph company, the oldest Atlantic company. We represent the first Atlantic Cable Company —that is the Anglo-American. I am its representative here with you, and as such it is hardly open to me to say all that I know on submarine telegraphy. The branch of it before you here to-night is not in my line of experience. It belongs to the electrical department. My special duty is to lay and repair cables. I was connected first with the Direct cable.

I was in command of the ship on the laying of that cable, and also the French cable; but now those gentlemen who were with us are in opposition to us. We are friends just the same, but I hardly think it right that we should give them all that we still have, when they are fighting us.

As you will have inferred from the description of the recorder here to-night, submarine telegraphy is rather a dry subject, except our branch of it, which is very wet sometimes. I do not know that I could interest you much. It would take too long to go into all the details of our work. They are very difficult at times and at other times we consider them tolerably easy. Of course, as you know, we have to do the fishing for these things at the bottom of the ocean, and we have played our part at that; and no matter what the gentlemen present may think of that

branch of electricity, I am quite sure you will all admit that the public could not well do without it. If we stopped the Atlantic cables, why some considerable amount of business would stop. Therefore you are to some extent depending on the telegraph cables. I thank you for the kind notice you have taken of me, and I beg you will excuse me from going into the matter of our operations, because it would take too long. I could not deal with it in such a manner, in the short time before us, as to make it any thing like interesting.

If any of you choose to come on board my ship which is in the dry dock at the Erie Basin, we can show you some things there that perhaps you would be interested in. We have no secrets. We are prepared to show anything that we have there. A great mystery has sometimes been made of submarine telegraphy; I think a little too much so—a feeling has prevailed that only certain individuals should know anything about it. We look upon cable telegraphy as a thing that is pretty well known to-day, and therefore we have nothing, so far as we are concerned, either as a ship, or a company, but what we are quite willing the world should look at.

I perhaps might say one word on the question of telephoning over submarine cables. My chief engineer is not here, but two of his assistants are present. They may remember. They were not with us at the time, but I dare say they know something about it. We did once put a telephone to the cable, I think 83 miles from shore, and spoke through it and heard their conversation back. I think that is the utmost which was done. We have had singing through the cable at much greater distance, and they could tell on shore the songs that were sung on the ship; but there was nothing in the shape of conversation, I think, beyond that distance, to my knowledge.

Mr. Schuyler S. Wheeler:—How deep can you grapple a cable.

Captain Trott:—To the bottom, sir; twenty-six hundred fathoms is the deepest water I have worked in.

The Secretary:—We understood from Mr. Cuttriss that we were indebted to Mr. Ward for the progress made in introducing Morse on the cables. A great proportion of American electricians know something about Morse, and of course they are interested in knowing just what has been done, and what more there is a prospect of doing, and I presume that information on that point will

be welcome if Mr. Ward could give us any further details regarding it. I should for one be very glad to hear from him.

MR. GEORGE G. WARD:—Mr. Cuttriss has told you as far as we have gone. We are working Morse on the Rockport cable. It was tried on the cable between St. Pierre and Cape Cod, but we found we could get no good results from it and it was abandoned. Since then nothing has been done on it, and the best results that have been obtained are, I believe, on this Rockport cable of ours between Canso and Rockport.

A MEMBER:—Would not Mr. Cuttriss kindly tell us something of the vibrator invented by Mr. Pescod that has been in use for several years past.

MR. CUTTRISS:—In reply to that, I would state that I cannot say anything about the vibrator. I have never seen it, nor have I seen any drawing of the method. I have heard that he does it by vibrating the whole coil under the siphon of a small Thomson recorder in which the siphon is attached to the coil. He vibrates the whole thing so that he lifts the siphon a small distance off the surface of the paper. That, I believe, is what his invention is. Whether he has made any other improvement since I heard of that I, do not know. I know that there is a counter claim between he and Mr. Dickenson. As to which is right in the matter I have no knowledge, and consequently I should not want to take up any ground one way or the other. The method is the same as Mr. Dickenson's practically, with the exception that Pescod vibrates the whole coil and Dickenson merely vibrates the siphon by pulling it with the paper.

MR. WARD:—With regard to the Morse, Mr. President, I should like to say that the relay used is the invention of an American gentleman. You said that the British were taking the steam out of the Americans in the cables; but this Allen and Brown relay was invented by a Mr. Brown, formerly associated with Mr. Edison in his automatic system. Mr. Allen is the financial part of the invention. So the British will not take credit for that.

MR. WHEELER:—I think this question of telephoning through cables is so important that it ought not be passed over lightly, and I would like to ask Mr. Cuttriss to tell us something about what can be done to overcome the induction. I mean, has the effect of a complete metallic circuit been tried, and have there been any induction devices used?

MR. CUTTRISS:—Mr. President, that is a hard one. Until you

can change the nature of a cable I don't think there is much hope of doing anything. Of course metallic circuits have been tried. I do not know that you gain anything by them. In fact if the two circuits are parallel from any distance I think that you probably would lose by them, for you are getting this whole reaction between the two parallel wires; that would act the same as a condenser, and there I must say that once speaking with Mr. Edison about this matter, he told me that he did not believe it would be possible for us to speak from the corner of Wall street down to the Coney Island hut through our underground cables for that very reason. He said he thought all the current would be neutralized, so to speak, or short-circuited probably would be the better term, before it got down to Water street. In that he was wrong. I have spoken from Wall street down to Coney Island very recently; and in one case where we had to open our cables to search for some trouble, at Flatbush, not half way to Coney Island, I spoke from the office to Flatbush direct, quite easily; but found that after concluding my test through that part, and having previously instructed them to go on the other end of the circuit, which was looped through our Coney Island hut and back to New York, so that we worked through three times the circuit, part of which was laid double and parallel; it was as much as I could do to hear the voices. Whether that arose from any action between the two cores, or what it was due to, I have not been able to determine, nor have I had any chances for pursuing experiments in that line. But I do not think that with long cables, a metallic circuit is going to be of any help. Of course a great deal depends upon where your circuit is. If you are in a straight away country road, then I should say, as I before stated, that I think the straight line is the better; but if you are coming over the Brooklyn Bridge, then I should say you would do better to come in a metallic circuit. Otherwise you get no speech at all on account of the induction of the other wires passing over the same route.

Mr. Wheeler:—Are we to understand from that, that a double wire would overcome the difficulty caused by the static capacity of the cable, but would bring up a greater difficulty, namely self-induction between the two limbs of the circuit.

Mr. Cuttriss:—I cannot say that I think the double circuit is going to overcome the static capacity at all. It cannot do it. The static capacity is still there. You would reduce your static

capacity by using the two to about one-half. But at the same time you are doubling the resistance. Of course, with a telephone that would not amount to much, because it would go through the resistance very easily, but it would bring about somewhat this effect of short circuiting across, the same as trying to talk through two parallel plates of a condenser. Of course this is all conjecture on my part, not having had a chance to try it. I think you would gain nothing by working over a good road clear of outside induction—you would get no gain by working in metallic circuit. I think a straight away line would be as good.

THE SECRETARY:—If I understand the gentleman correctly, the capacity of the recorders as now operated is such that it does not appear that anything is to be gained by telephoning over a cable, excepting as a matter of experiment; that is, unless the telephone system was a great deal better than our local service, I would much prefer a siphon recorder for accuracy in the transmission of business.

MR. CUTTRISS:—On that point probably I could give a little light. The same day that Mr. Gower came down to Duxbury to try his electric harp he informed us what a wonderfully beautiful thing this was going to be to speak across the ocean. Well, having that trouble with the mirror, in distinguishing between the sounds "M" and "N," "P" and "B" and other letters, we rather doubted it, but we thought we would make a trial of it. So he went up stairs with one telephone, and we had the smartest of our clerks with a telephone down at the other end, and we took up what was then one of the most beautiful of cable messages, a "Stoker." If a man could make anything out of the words of a "Stoker" message he could understand almost anything. We told him to speak that message through his telephone to the clerk down stairs who should write it down, and then the clerk should repeat it back to Mr. Gower, who should also correct it from the copy. I think, if my memory serves me right, the message contained something like forty words. The clerk down stairs made over eighty errors. It was repeated back to Mr. Gower. There were two telephones in the circuit. Mr. Gower was listening at one and another gentleman at the other, and Mr. Gower corrected, as he supposed, forty of the errors; but there immediately arose a dispute between Mr. Gower and the other gentleman as to what certain letters were, that were being sent. Now, there were two people listening in the same circuit and yet they could not agree

as to what one letter was. So long as a telephone will not speak more clearly than that through a room you can imagine what it will be through a long cable.

THE SECRETARY:—That coincides with my early experience with the telephone. Our telephone line was connected with the Western Union Supply Department and I had occasion to inquire of that Department about the shipment of three or four carboys of acid to Charleston, South Carolina. I got along with the whole business until the man at the other end attempted to tell me the name of the schooner by which it was shipped. It was a simple name, Mary Jane or something of that kind. But of course there was no context to give me a clue as to what the name was. In other words, to telephone successfully you must have an inkling of the business that is to be transacted, and who the person is who is sending it. I have had occasion once in a while to answer the inquiry, "Who is at the telephone?" and before I could succeed in making them understand that my name was "Pope" I would get disgusted and give it up. I presume that is one of the names that does not go through a telephone very well. This is one of the difficulties I have always apprehended in connection with this proposition of telephoning commercial messages, and those who were most ardent in their advocacy of telephoning messages for commercial purposes were those who were not familiar with the facility with which a Morse operator can receive either proper nouns or cipher messages or anything of that kind, and the same would apply to cable messages. Of course most of us understand that the bulk of the business transmitted over the cables is in cipher, and I doubt whether it would be possible to carry on the cable business as it is to-day with the best working telephone line there is in existence.

MR. F. BENNETT:—I understand Mr. Cuttriss to say that the diaphragm of the telephone responded to the undulations of the current but not in rapid enough succession to be audible. Now, supposing this diaphragm had a needle on it such as there is on the phonograph and that the cylinder like that of the phonograph, was to be rotated at a given speed, and the undulations of the diaphragm repeated on the tin foil of the phonograph, and after the message was sent, let the cylinder be rotated at a more rapid pace, would it not cause the undulations of speech to be reproduced so rapidly as to be audible to the human ear?

MR. CUTTRISS:—In my reply I would say that it certainly

would not be heard at the other end. There is no reason why the current from the phonograph should be any stronger than one from any intermediate source. The electrical harp that I spoke of Mr. Gower's using, was merely a rapidly interrupted circuit, according to any note that he struck. The harp contained about two octaves, and of course we had any range, within those two octaves in which to try it, but no sound was received there at all, and in that, he used, I think, four cells of Leclanche and a powerful induction coil, the current from which was strong enough to give you a very disagreeable shock. So you can see, if that would not go, there would be no reason why anything from a phonograph would. It is exactly as Mr. Lockwood said in his paper; the currents are small and go with such infinite rapidity that they are neutralized before they get to the other end. They are actually swamped, and that is the reason why you cannot get anything through. The receiving currents of course came through his instrument because they came slow and were powerful enough to deflect his diaphragm. If we had a make-and-break on there it is possible we could have opened and broken the circuit from the diaphragm. Still, you can see why we could get no audible effect, for the moment we began to increase our speed sufficiently to bring it up to the point, we were sending the currents so rapidly into the cable that they were beginning to neutralize one another, and before we could get to the audible rate they were neutralized—probably before they got twenty miles from the station.

Mr. Bennett:—I think Mr. Cuttriss did not fully understand my meaning. We will take for illustration the old register where it makes the dots and dashes on the paper. Of course we understand that that rotates at a given velocity, the same as does the cylinder of the phonograph. Now, supposing the cylinder on the phonograph was revolving the same as it does in the siphon recorder, it would cause the undulations, or the dots and dashes for instance, to make indentations in the tin-foil, and then by revolving the cylinder faster it would cause sharper vibrations in the diaphragm and therefore cause it to be more audible.

Mr. Cuttriss:—Certainly, that would be so. But what advantage would you get from obtaining a sound in that way, if it took you probably half an hour to get sufficient signals over the cable to move the diaphragm; that is, if it took you half an hour to get sufficient signals over the cable to be made audible through

the diphragm, by rotating the cylinder afterwards rapidly. I do not see what gain you would get, because your signals would have to come very slowly to indent the tin-foil at all, and you are certainly going to get no gain, because you cannot send reversals, that is alternate positive and negative currents. You cannot send the same number of words over it per minute as you can by using what we term a mixed signal. The reversal has got to be a charge to one polarity from another—a mixed signal, as we term it, the same as in the letter "S," where it goes up with the wave; all you need is that wave, and the length of the wave, to show that three signals have gone. Therefore, the sending of reversals through the cable does not increase the speed.

THE SECRETARY:—I would say before we close, Mr. President, that these questions that have come up in regard to what can and what cannot be done over a cable, can be looked at, I presume, from two different points—from the experimental point, and from the commercial point. As matters of experiment they may be very interesting, but commercially we must remember that the cable is a very expensive affair; its service is expensive, and it is necessary to utilize every moment of time. Consequently any system that is introduced must be an improvement in speed, or an improvement by reason of doing away with these detentions and faults in apparatus which Mr. Cuttriss has brought to our attention in describing the older forms of instruments. As I understand it, the improvement has been in the continuity of the service rather than the speed, that is, doing away with detentions caused by repeating back signals, and also by failures of the apparatus.

THE PRESIDENT:—The hour of closing having arrived and there being no further discussion the meeting is adjourned.

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OF

CURRENT ELECTRICAL LITERATURE.

It is the intention to include in this Index, month by month, as far as desirable and possible, all the articles on electrical subjects, of scientific and technical importance, published in electrical and other journals, and the papers read before the various technical societies. The titles will be classified so as to present at a glance the range of current discussion and the advance of investigation or discovery in the different fields of work.

The Secretary will be under obligations to any member who may supply, or call attention to, any omission noted, and will be glad to have suggestions tending to render the Index more valuable now and for future reference. He will be happy also to co-operate in this respect with members prosecuting special studies and experiments.

Subsequent issues will comprise the French, German and other journals in foreign languages.

The Index sheets are printed separately so that they may be detached at once, if necessary. They will all be bound together at the end of each Volume of Transactions.

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The History of the Phonic Wheel and its Application to Synchronous Multiplex Telegraphy. (Ill.) Paul La Cour. *Lond. Elec. Rev.*, Oct. 7, (cont'd.)

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